VERSION WITH MARKINGS TO SHOW CHANGES MADE

SPECIFICATION:

Specification at page 1, line 3:

This application is a division of U.S. Patent Application No. 09/177,038 filed October 22, 1998.

Specification at page 3, line 16:

~~**SUMMARY OF THE INVENTION**~~

~~The present invention is made to solve the above conventional problems and its object is to provide a semiconductor device capable of integrating a ferroelectric thin film free from characteristic deterioration and its fabrication method.~~

~~A semiconductor device of the present invention comprises~~

~~a circuit board,~~

~~a ferroelectric capacitor arranged on said circuit board, having a ferroelectric thin film and top and bottom electrodes which are formed so as to hold said ferroelectric thin film,~~

~~an insulating film formed on said circuit board so as to cover said ferroelectric capacitor,~~

~~a metallic wiring film formed on said insulating film so as to connect with either of said top and bottom electrodes, and~~

~~a surface protective film formed so as to cover said insulating film and said metallic wiring film, wherein~~

~~a synthetic stress working in a surface direction of the ferroelectric thin film of said ferroelectric capacitor is an extensional stress.~~

~~The semiconductor device according to claim 1 of the present invention, is such that~~

~~said insulating film, metallic wiring film, and surface protective film provide the surface-directional extensional stress of the ferroelectric thin film of said ferroelectric capacitor.~~

~~The semiconductor device according to claim 1 or 2 of the present invention is such that~~

~~Said metallic wiring film is constituted with two layers which are different kinds of metal.~~

~~A semiconductor device fabrication method for fabricating the semiconductor device of the present invention comprises the step of:~~

~~forming said insulating film on said ferroelectric capacitor by the TEOS CVD method utilizing TEOS activated by O3.~~

~~A semiconductor device fabrication method for fabricating the semiconductor device of the present invention is such that~~

~~said metallic wiring film is constituted with two layers where a bottom layer thereof is made of TiN, and~~

~~such step of heat-treating of said formed TiN layer in a tempteture range of 200 to 650°C after forming said TiN layer is included.~~

~~A semiconductor device fabrication method for fabricating the semiconductor device of the present invention is such that~~

~~said metallic wiring film is constituted with two layers where a top layer thereof is made of A1, and~~

~~such step of forming said A1 layer through the sputtering method while heating said circuit board in a tempeture range of 100 to 400°C is included.~~

~~A semiconductor device fabrication method for fabricating the semiconductor device of the present invention is such that~~

~~said surface protective film is made of SiN, and~~

~~such step of forming said surface protective film by depositing SiN through the plasma excitation CVD method having an RF power of 300 W or less is included.~~

~~The above semiconductor device of the present invention can show a superior performance that the ferroelectric pair thin film of the ferroelectric capacitor is not deteriorated.~~

~~Moreover, the semiconductor device fabrication method of the present invention can realize a semiconductor device having the above superior performance.~~

SUMMARY OF THE INVENTION

The present invention is made to solve the above conventional problems and its object is to provide a semiconductor device capable of integrating a ferroelectric thin film free from characteristic deterioration and its fabrication method.

A semiconductor device of the present invention comprises a circuit board, a ferroelectric capacitor arrange on the circuit board having a ferroelectric think film and top and bottom electrodes which are formed so as to hold said ferroelectric thin film, an insulating film formed on the circuit board so as to cover said ferroelectric capacitor, a metallic wiring film formed on the insulating film so as to connect with either of the top and bottom electrodes, and a surface protective film formed so as to cover the insulating film and the metallic wiring film, wherein a synthetic stress working in a surface direction of the ferroelectric thin film of said ferroelectric capacitor is an extensional stress.

In another aspect of the present invention, the insulating film, metallic wiring film, and surface protective film provide the surface-directional extensional stress of the ferroelectric thin film of the ferroelectric capacitor.

In a further aspect of the present invention, the metallic wiring film is constituted with two layers which are different kinds of metal.

A semiconductor device fabrication method for fabricating the semiconductor device of the present invention comprises the step of: forming said insulating film on said ferroelectric capacitor by the TEOS-CVD method utilizing TEOS activated by 0_3.

A semiconductor device fabrication method for fabricating the semiconductor device of a further aspect of the present invention is such that the metallic wiring film is constituted with two layers where a bottom layer thereof is made of TiN, and such step of heat-treating of said formed TiN layer

in a temperature range of 200 to 650°C after forming said TiN layer is included.

A semiconductor device fabrication method for fabricating the semiconductor device of another aspect of the present invention is such that said metallic wiring film is constituted with two layers where a top layer thereof is made of Al, and such step of forming said Al layer through the sputtering method while heating said circuit board in a temperature range of 100 to 400°C is included.

A semiconductor device fabrication method for fabricating the semiconductor device of a still further aspect of the present invention is such that said surface protective film is made of SiN, and such step of forming said surface protective film by depositing SiN through the plasma-excitation CVD method having an RF power of 300 W or less is included.

The above semiconductor device of the present invention can show a superior performance that the ferroelectric-pair thin film of the ferroelectric capacitor is not deteriorated.

Moreover, the semiconductor device fabrication method of the present invention can realize a semiconductor device having the above superior performance.

Specification at page 7, line 6:

The semiconductor device of this embodiment is characterized in that the sum of stresses of thin films deposited on the ferroelectric capacitor is an extensional stress. In FIG. 1, arrows show stress directions of thin films. Because the sum of stresses of thin films formed on the ferroelectric capacitor has an extensional direction, an extensional stress or tensile is applied to the ferroelectric capacitor to prevent ferroelectric characteristics from deteriorating.

Specification at page 7, line 15:

Moreover, the semiconductor device of this embodiment is characterized in that every thin film deposited on the ferroelectric capacitor applies an extension-directional stress to the ferroelectric capacitor. Because every thin film deposited on the ferroelectric capacitor has an extension-directional stress, an extensional or tensile (hereinafter "extensional") stress is applied to the ferroelectric capacitor to prevent ferroelectric characteristic from deteriorating.

CLAIMS:

Claims 1-4, 6, 7, 10, 13 and 15 have been canceled.

5. (Amended) The [A semiconductor device fabrication] method for forming a [fabricating the] semiconductor device according to claim 16 [2; comprising the], in which said step f1) includes [of]:

depositing [forming] said second insulating film [on said ferroelectric capacitor by the] using a TEOS-CVD method utilizing TEOS activated by O_3.

8. (Amended) The [A semiconductor device fabrication] method for forming a [fabricating the] semiconductor device according to claim 16 [2], [wherein]in which said step f2) includes forming a metal

[said metallic] wiring film by: a) depositing a [is constituted with two layers where a bottom layer thereof is made of] TiN[, and] layer, and b) depositing an upper layer

[such step of heat-treating of said formed TiN layer in a temperature range of 200 to 650°C after forming said TiN layer is included].

9. (Amended) The [A semiconductor device fabrication] method for forming a [fabricating the] semiconductor device according to claim [3] 8,[wherein] in which said step of forming a metal wiring film further includes

[said metallic wiring film is constituted with two layers where a bottom layer thereof is made of TiN, and

such step of] heat-treating [of] said [formed] TiN layer in a temperature range of 200 to 650°C after forming said TiN layer [is included].

11. (Amended) The [A semiconductor device fabrication] method for forming a [fabricating the] semiconductor device according to claim 16 [2], [wherein]in which said step f2) includes forming a metal

[said metallic] wiring film by: a) depositing a base layer, and b) depositing an [is constituted with two layers where a top layer thereof is made of Al, and

such step of forming said] Al layer [through the sputtering method while heating said circuit board in a temperature range of 100 to 400°C is included].

12. (Amended) The [A semiconductor device fabrication] method for forming a [fabricating the] semiconductor device according to claim 11[3], wherein

said [metallic wiring film is constituted with two layers where a top layer thereof is made of Al, and

such] step of depositing an [forming said] Al layer comprises [through the] sputtering [method] while heating said circuit board in a temperature range of 100 to 400°C [is included].

14. (Amended) The [A semiconductor device fabrication] method for forming a [fabricating the] semiconductor device according to claim 16 [2], wherein

said [surface protective film is made of SiN, and

such] step of forming said surface protective film comprises [by] depositing SiN through [the] a plasma-excitation CVD method having an RF power of 300 W or less [is included].

Claims 16 and 17 have been added.